The effects of catchment landuse on estuaries - using macroinvertebrates as bio-indicators

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Declarations

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Abstract

Benthic macroinvertebrates are often used bio-indicators of pollution as they readily respond to changes in their environment. However, within estuaries natural variation in macrofaunal assemblages can be extensive, inhibiting our ability to detect changes that occur as a result of human impact. For effective management of threats and for developing cost effective monitoring programs a clear understanding of both natural and anthropogenic factors affecting macrofaunal communities is required. In this study natural variation in macrofaunal assemblages and that which can be attributed to anthropogenic disturbance is examined in twelve Tasmanian estuaries. Two common geomorphologically different estuarine types (seven mesotidal river dominated estuaries and five permanently open barrier estuaries) were surveyed on one occasion in November 2008. The first aim of this study is to gain a greater understanding of the natural processes driving macrofaunal assemblages in both estuarine types, to assess how similar or dissimilar they are and whether these patterns are dependent on the location of sampling. This information is important as it provides information on biogeographical patterns in the distribution of macrofaunal assemblages and the mechanisms that drive these patterns. This information can also be used to ascertain whether the same or separate management strategies can be implemented for the two different estuarine types. To assess changes in the composition of macrofaunal assemblages along natural gradients each estuary was divided into upper, mid and a lower location that were broadly comparable across estuaries. This allowed a comparison of similar locations across estuaries, reducing the effects of natural variation within each estuary. At each location, a suite of variables commonly used in monitoring programs were collected, which included macroinvertebrates, seagrass extent, dissolved oxygen in the water column, pore water salinity, sediment nutrients (total nitrogen and phosphorus) and sediment for particle size analysis, stable isotope analysis (used only in the second data chapter) and microphytobenthos. Using the same macrofauna and environmental data the second aim of this study investigated the effects of anthropogenic impacts in mesotidal river estuaries,

relating the composition of macrofaunal assemblages to nutrient loads generated from catchment landuse activities. As each estuary was divided into an upper, mid and lower location it also provided an opportunity to assess where in the estuary greatest impacts are likely to occur providing valuable information to managers for developing cost effective monitoring programs.

Differences in macrofaunal assemblages between estuarine types occurred at the lower and mid sampling locations; however no difference was detected between the upper macrofaunal assemblages. The variation in macrofaunal assemblages between estuarine types were related to differences in salinity, seagrass extent and dissolved oxygen concentrations. Macrofaunal assemblages in mesotidal river estuaries differed between upper, mid and lower locations. In contrast, the macrofaunal assemblages of open barrier estuaries were similar in the upper and mid location, but these differed from macrofaunal assemblages in the lower location. The natural variation in macrofaunal assemblages within estuaries corresponded with a strong downstream sediment grain size gradient that covaried with changes in total nitrogen, % organic carbon and microphytobenthos concentrations.

In the mesotidal river estuaries with the highest nutrient loads there was a shift in the composition of macrofaunal assemblages, particularly in the upper and mid locations. In the upper location of estuaries with the highest nutrient loads there was a reduction in species diversity and assemblages were dominated by small, highly abundant surface deposit feeding species. At the mid estuary location, differences in species richness were not evident, but assemblages were dominated by infaunal surface deposit feeding species in estuaries with higher nutrient loads. In comparison, a more diverse macrofaunal assemblage that represented a range of trophic feeding groups was observed in estuaries with lower nutrient loads. The shift in the composition of macrofaunal assemblages in the upper and mid locations of estuaries with high nutrient loads appears to be related to silt loading, elevated sediment nutrient concentration and reduced water column dissolved oxygen concentrations. Also indicative of the relative influence of

anthropogenic loads of nitrogen, a similar pattern was observed in the sediment signature of δ^{15}N, where elevated signatures were detected in the upper and mid locations of estuaries with highest nutrient loads. In contrast, the results indicated that the lower locations were predominantly influenced by marine processes or by processes not measured in this study. The low sediment signatures of δ^{15}N at the lower location provide further support to this argument.

Overall, this study demonstrates that dividing the estuaries into locations was essential in capturing and explaining the natural variability in the distribution of macrofauna, and allowed a comprehensive investigation into the relationships between nutrient loads and macrofaunal assemblages. This has direct application to the design of cost effective monitoring programs that use macrofauna as an indicator of anthropogenic change. This information is useful in determining if similar management strategies and monitoring programs can be applied to both estuarine types.

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